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INDUSTRIAL ACTIVITY AT CERN

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Abstract

The decrease in the number of CERN staff creates the need for optimization of the non-core, infrastructure-related activities. An industrial, service-orientated approach has long been considered as an appropriate way to cope with the problem of diminishing resources. This paper presents industrial and service activity issues at CERN based on the experience of the exploitation of the power network. The most important problems linked to the application of the industrial approach to the exploitation of equipment in the CERN research environment are covered. These include the interface between accelerators and electrical exploitation services, external and internal regulations, sharing of responsibility between CERN staff and external contractors, continuous modification of clients' requirements, the balance between the cost of accelerator downtime versus the cost of infrastructure upgrade. A benchmarking through a comparison with a big industrial manufacturer is followed by recommendations for possible improvements.

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1 INTRODUCTION

Following the decrease in the number of CERN staff and, at the same time, facing increasing requirements concerning the efficiency of the technical services, the ST division considers the industrial approach as a solution to these problems. An obvious question of the applicability of this approach to the research environment has to be asked. The main difference is obviously the fact that CERN is a non-profit organization. A number of other factors contribute to the problem. This paper tries to follow the present trends in the industrial approach to maintenance and operation and compares them to the activities of the electrical exploitation. As a result it can be seen that some of the industrial approach is entirely applied (cost optimization), some trends are being introduced but not yet completely or do not give the required results (reliability-centred approach, outsourcing), and some are not applicable to CERN as a non-manufacturing organization (total productive maintenance).

2 DECREASE IN THE NUMBER OF CERN STAFF

The decrease in the number of the CERN staff is a well known fact. The decrease in the number of technical personnel in professional categories 3 and 4 follows the general trend. Their numbers will decrease in the next 6 years by 35–40%[1]. As complements are not possible according to the present CERN personnel policy, the shortage of human resources must be coped with by the application of new organization, modern management, new technologies, and outsourcing.

3 INDUSTRIAL APPROACH

In this section the methods, considered to be tools of the industrial approach, are given. They are widely applied in the industry of today. The list, not exhaustive, includes

- cost optimization,
- reliability-centred maintenance,
- asset management versus maintenance management,
- total quality maintenance,
- outsourcing of industrial activities.

As an example of the use of the contemporary approach to maintenance, a DuPont example will be shown.

3.1 Cost optimization

The cost optimization approach to operation and maintenance is defined as the methodology that aims at O&M cost decreases without changing the scope of the activities. The principal actions resulting from the cost optimization approach are

- grouping of interventions (economy of scale),
- re-scheduling in order to smooth the use of resources,
- contract consolidation.

The obvious deficiency of cost optimization is a narrow approach: doing things right instead of doing right things.

3.2 Reliability-centred maintenance

Reliability-Centred Maintenance (RCM) is an approach that aims at the improvement of performance by applying maintenance resources where they are the most effective.

[1] According to the estimates of PE division.

The performance of too much preventive maintenance can result in high labour costs and reduced equipment availability. Too little preventive maintenance can result in equipment failures, which cause production stoppages plus high corrective maintenance costs.

An effective maintenance programme will include the proper balance between preventive, predictive, and 'operate-to-failure' maintenance by ensuring that the right preventive maintenance activities are focused on the equipment where the consequence of failure is greatest. RCM includes a series of steps that identify equipment importance (based on safety, production and other costs) possible preventive/predictive maintenance tasks, design changes, or other changes that could improve equipment reliability and then identify which of the tasks would be the most effective to implement.

3.3 Asset management versus maintenance management

The more general (compared to maintenance management) approach of asset management relies on the principle of the total ownership cost instead of operation and maintenance cost. The consolidation and replacement costs are included in the ownership cost together with the operation and maintenance costs.

3.4 Total productive maintenance

Total Productive Maintenance (TPM) follows the principles of total quality management applied to operation and maintenance. It stresses the involvement of personnel in the maintenance activities as well as the integration of the maintenance processes in the production chain. This approach aims at

- creating a collective culture dedicated to the attainment of maximum efficiency throughout the production process;
- using the system so as to prevent losses and to have in the manufacturing process no accidents, no defects, and no breakdowns;
- involving the entire workforce. The management provides commitment and a clear TPM vision. The targets are then deployed at an intermediate level down to production line operators;
- having no losses through the results of the activity of teams integrated into the production system;
- being present in all aspects of the company.

Both operations and maintenance departments should accept the responsibility of keeping equipment in good condition. To eliminate the waste and losses hidden in a typical factory environment, we must acknowledge the central role of workers in managing the production process. No matter how thoroughly plants are automated or how many robots are installed, people are ultimately responsible for equipment operation and maintenance. Every aspect of a machine's performance, whether good or bad, can be traced back to a human act or omission. Therefore no matter how advanced the technology, people play a key role in maintaining the optimum performance of the equipment.

3.5 The DuPont experience: 'uptime excellence' in maintenance

DuPont integrated the maintenance function with the business cycle. This method provides a clear definition of equipment utilization, identifies opportunities for continuous improvement, fixes benchmarks against which progress can be tracked, and enables allocation of sufficient resources.

At the Maitland site, DuPont carried out a series of benchmarking audits and identified maintenance best practices. These were used to eliminate defects and increase asset reliability.

Uptime excellence focuses on the processes involved in improving resource effectiveness. Uptime is the equivalent amount of time a plant operates at its demonstrated rate making a top quality product. It is also a systemic view of manufacturing that pinpoints specific elements in the process which limit productivity. These elements, or uptime detractors, are such things as scheduled and unscheduled downtime, process-related rate losses, quality yield losses, and product transition losses.

DuPont Canada implemented its uptime excellence using a set of tools:

- Root cause failure analysis
- Cost/performance optimization
- Establishment equipment histories
- Critical material specification
- Priority for training
- Introduction of multi-skilling
- Planning and scheduling
- Practice of predictive and preventive maintenance
- Reliability-centred maintenance.

As a result the company has achieved a significant decrease of the total maintenance cost with the simultaneous reduction of production downtime.

3.6 Outsourcing of non-core activities

Of the many different definitions of outsourcing in this paper the author's preferred one is:

'*Coherent management strategy to capture benefits from the systematic buying-in of non-core services*'[2]

Given the size of the paper only a brief summary of advantages and disadvantages of outsourcing is given below.

- Advantages:
  - reduced personnel and associated costs;
  - reallocation of management resources to core activity;
  - flexibility to respond to short-term peaks of demand;
  - reduced administrative burden;
  - improved management control and accountability.
- Disadvantages:
  - a necessary initial period of organizational learning for the facilities manager;
  - a temptation to buy a package that includes irrelevant extras as opposed to buying what is really needed;
  - becoming locked in a structured contract that is not designed to respond to changing circumstances;
  - possible negative staff association (union) reaction;
  - a perceived threat by employees.

4 INDUSTRIAL APPROACH IN THE ELECTRICAL EXPLOITATION

The main difficulty in the application of the industrial approach is of course the fact that ST electrical exploitation does not operate in the industrial environment. The description of the application of the different elements of the industrial approach in the CERN environment has been completed by benchmarking with the maintenance team of Aluminium Dunkerque, Pechiney Group, which was conducted on 14 December 1999.

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[2] Oliver Jones in 'Outsourcing non-core services' by Quadrilect.

4.1 Cost optimization

The cost optimization approach is widely applied in electrical exploitation. The consolidation of the maintenance contracts, simplification of maintenance ranges, and changes in frequency of interventions are the most typical examples.

More attention should be paid to the comparison of the effects of preventive and corrective maintenance. Also an increasing role of predictive maintenance will be expected.

Benchmarking: the maintenance contracts are revised yearly. The maintenance team reviews the maintenance ranges and frequencies. The experience with predictive maintenance is considered as non-conclusive.

4.2 Reliability-centred maintenance

The application of the RCM approach in the electrical exploitation is based more on the 'what if…' assumption than on the failure statistics. This means that even if, to a certain degree, the consequence of the breakdown is taken into consideration, the probability of its occurrence is not.

Benchmarking: exactly the same approach and results.

4.3 Asset management and maintenance management

Asset management has a relatively wide application as far as single pieces of equipment is concerned. The cost of repair of a broken transformer is a sufficient argument for the purchase of a new one. This unfortunately does not apply to large systems, where the size of the necessary investment and especially its spread over several years constitute a barrier for implementation. Additionally, preparation of each of the projects requires high-quality manpower.

Benchmarking: follow up of the total cost of ownership for the equipment.

4.4 Total productive maintenance

The fact that there is no industrial production at CERN is the main factor limiting the application of this approach to CERN. Also the fact that there is a strict division between users and infrastructure and staff does not encourage them to be involved in interventions on the equipment belonging to the other party. Similarly within the ST division the tendency is not to intervene on other groups' equipment.

For other aspects of total productive maintenance, the lack of a visible management commitment does not encourage commitment at the operator's level.

Benchmarking: production team members pass a significant (20%) part of their time in the maintenance team. Depending on their capacity they perform first-line interventions, of a duration of up to one hour, on the infrastructure.

4.5 Outsourcing of non-core activities

Outsourcing of the electrical exploitation activities is mostly done in the preventive maintenance domain. The maintenance of transformers, low-voltage switchboards, as well as batteries and battery chargers is performed by the contractor and paid for according to the item price list principle. CERN staff assure complete budget control and partial technical control. Additionally some corrective maintenance is paid according to the hours worked. An important part of the maintenance contract is used in the form of support personnel, who work under supervision of the CERN staff.

Benchmarking: contractors are used for the preventive and corrective maintenance of the equipment under complete control of the staff. The contracts are established yearly and comprise both preventive and corrective maintenance. Best experience was obtained with the original manufacturers. Performance indicators are used for lighting, air conditioning, ventilation, roads and green areas.

4.6 Other problems linked to the application of the industrial approach to electrical exploitation at CERN

4.6.1 Interface between accelerators and electrical exploitation

The interface between the accelerators and exploitation is assured via numerous meetings, committees and working groups. These often result in contradictory requirements especially concerning planning of the shutdown work. Although it seems impossible to have one contact for all machines and experiments, with a smaller number of contacts less time would be used for co-ordination and less errors in planning would be encountered. The multiple interfaces result also in a continuous modification of users' requirements. This concerns not only exploitation but also, to an even greater extent, projects.

Benchmarking: for the whole of the maintenance team there is one contact per factory division for planning of maintenance, equipment modifications, and new investments.

4.6.2 External and internal regulations

Incoherence between external and internal regulations creates an important increase of activity for the electrical exploitation. The two most important examples are electrical safety certificates and emergency stop regulations.

Safety certificates

According to the CERN safety code C1 the electrical exploitation safety instructions should follow the French standard UTE C18-510. This standard requires that all persons involved in manoeuvres, interventions, locking-out and working with the electrical equipment should be in possession of a valid certificate. This requirement is fulfilled only with respect to external staff but not the CERN personnel. The electrical exploitation team insisted on the TIS Commission's preparing a safety instruction, which would clarify this issue.

An additional problem is created by the fact that external companies coming from countries other than France, although having national certificates, in order to comply with safety requirement should be issued with suitable certificates according to the French standard.

Benchmarking: There is no separate safety division. Interpretation of safety standards and regulation is done by the engineering department. Safety rounds are assured by exploitation personnel.

Emergency stop system

The emergency stop system was installed initially in certain workshops, test areas and experiments, where the complexity of installations and their temporary character justified this means of protection. However, safety instruction No. 5 enlarged the area of application of the emergency stop. The number of emergency stop buttons has been steadily increasing since then, reaching the incredible number of 10 000. It must be noted, however, that a working group between ST and TIS divisions was created recently to investigate this problem with the ambitious aim of a 40% reduction in the number of emergency stops.

Benchmarking: The use of the emergency stop buttons in the Aluminium Dunkerque site is limited to the main industrial process halls. No emergency stops are installed in workshops, laboratories, and electrical substations.

4.6.3 Sharing responsibility between CERN staff and contractors

The question arises how much responsibility should be given to the outsourcing contractors. Presently the CERN staff plays the role of the interface between the contractor and CERN users. Also strict financial control and quite rigorous technical control is done by the electrical exploitation team for the preventive maintenance interventions. This is possible due to the extensive use of the CAMM system and elaboration of the Quality Assurance Plan. The same approach will be used for the new contract, which will also include subcontracting of the operation. Nevertheless, after the initial phase, the electrical exploitation interface will be reduced.

Benchmarking: the maintenance division keeps full technical and financial control over the contractors.

4.6.4 Cost of accelerator downtime versus cost of maintenance

The cost of one hour of the LEP machine operation was estimated in 1990 to be approximately 120 000 CHF and recently brought to 150 000 CHF. However, this number has rarely (never?) been used to support either new investments in the infrastructure or consolidation projects.

Benchmarking: the cost of the stop of the production line is exactly defined and used both for evaluation of the maintenance effectiveness and for infrastructure improvement projects.

5 CONCLUSIONS

The electrical exploitation team tries to follow the industrial approach to maintenance and operation. The main difficulties with the application of this approach are CERN's being a non-profit organization and the specific research environment in which the team has to operate.

Three elements of the industrial approach are believed to be a solution to the current problems: outsourcing, asset management, and reliability-centred maintenance. The electrical exploitation team should consider these trends as main guidelines for the future.

The cost of accelerator downtime should be defined and used for evaluation of the maintenance effectiveness and for approval of the infrastructure upgrade projects.

A benchmarking with other research centres of similar size as well as with important industrial sites should be widely used for evaluation of the exploitation.